

primary decision-making body overseeing the planning process, consists of coastal restoration scientists, managers, and planners; directors of key conservation organizations; and representatives of jurisdictional, regulatory and governmental entities. During the past year, they developed a consensus statement outlining strategic planning principles, a vision, goals and objectives for the TWP. Summarized, the goals are to conserve the existing highest-quality estuarine habitats; restore and enhance degraded estuarine habitats, with a special emphasis on those with the highest loss rates; and restore and enhance natural processes (hydrology and geomorphology) to sustain a more stable estuarine system. The team has also agreed that the current tidal habitat trends are not acceptable and that new management actions are necessary.

A TWP Science Panel, consisting of more than 40 multidisciplinary (biological, hydrogeomorphic, physiochemical, estuarine restoration) experts has met bimonthly over the past year. This group has been instrumental in characterizing what is known about historical changes, tidal habitats, physical processes and causes of tidal erosion and marsh loss. There is now general agreement that the modification of the Elkhorn Slough mouth for the creation of a harbor in 1947, permanently fixing a deeper opening to Monterey Bay, is the main cause of subtidal erosion and more recent marsh loss. Contributing factors include decreases in sediment supply (diversion of the Salinas River), dike/levee failure and removal, the presence of the Monterey Canyon, sea-level rise, wave action and other biogeochemical processes. The panel acknowledges that the process of marsh loss is complex, but the increased tidal range and duration of tidal inundation on the marsh plain (due to the mouth modifications and land subsidence) in combination with the decrease in sediment supply are contributing factors.

The TWP Science Panel and Strategic Planning Team have also agreed that the Elkhorn Slough system is not currently at equilibrium. Their predictions for tidal habitats over the next 50 years, if no actions are taken, include the continued deepening and widening of the channel and tidal creeks, increase in salt marsh conversion to mudflat and tidal creeks, and erosion of sediments in soft-bottom areas.

The next major step in the tidal wetland planning process will be to develop and evaluate potential strategies that achieve the goals to conserve and restore tidal habitats in Elkhorn Slough.

Possible strategies to address marsh loss and tidal erosion may include actions to reduce the tidal influence to specific areas or the entire system, to supply sediments to increase the elevations of subsided marsh areas and to restore appropriate levels of tidal exchange to areas behind water-control structures. Key agency and community stakeholders and outside experts will be able to provide input on the draft strategies. The anticipated result of the TWP will be that the partners will be in place to obtain funding, oversee implementation and conduct research and monitoring of the recommended conservation and restoration strategies.

Strategies in the Elkhorn Slough TWP will aim to meet the shared vision of the Strategic Planning Team: "We envision a mosaic of estuarine communities of historic precedence that are sustained by natural tidal, fluvial, sedimentary and biological processes in the Elkhorn Slough Watershed as a legacy for future generations."

For more information, please visit www.elkhornslough.org/tidalwetlandplan.htm.

— BARB PEICHEL
ELKHORN SLOUGH NATIONAL ESTUARINE RESEARCH RESERVE

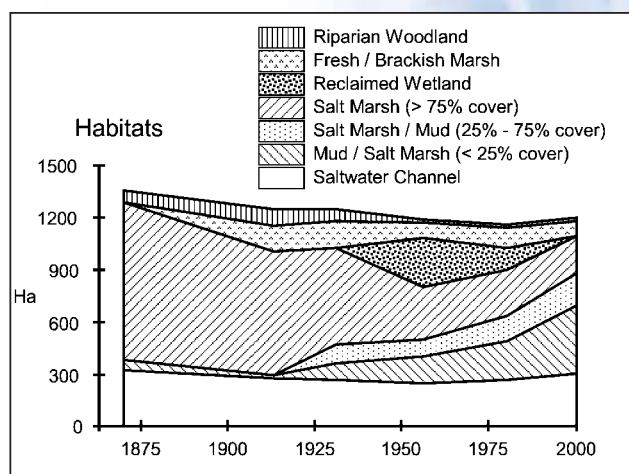
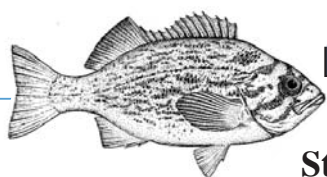


Figure 1. Changes to the extent of acreage (hectares; ha) of tidal habitats in Elkhorn Slough from 1870 to 2000 (Van Dyke and Wasson 2005)



ENDANGERED AND THREATENED SPECIES

Steelhead are Widespread but Sparse in the Sanctuary

Each winter, hundreds of ocean-going steelhead, *Oncorhynchus mykiss*, return to the Monterey Bay National Marine Sanctuary to ascend local streams and spawn. A century ago, this number was almost certainly in the tens of thousands, but it has undergone a long decline. This is presumably due to the myriad effects of the growing human population on stream habitat; regional climate change; and especially the construction of impassable dams, culverts and other obstructions that block their freshwater migration routes.

The steelhead were listed as threatened (under the Endangered Species Act) in the 1990s, after the California drought put the situation in stark relief: from 1988 to 1992, only 16 adults were observed ascending the fish ladder at San Clemente Dam on the

Carmel River. At that time, we knew very little about steelhead abundance in the other two inland systems – the Salinas and Pajaro – but we knew that the human impacts in those systems were at least on par with the Carmel River. We also knew that some modest runs occurred in various coastal basins between San Francisco and Cambria.

Since then, we have learned more about the steelhead – findings both alarming and comforting. Much of the current situation derives from steelhead's dependence on accessible stream reaches with cool, reliable base flows during the summer in which their offspring can successfully 'oversummer' before migrating out to the ocean. Rainbow trout also play a key role, as do estuaries (see text below).

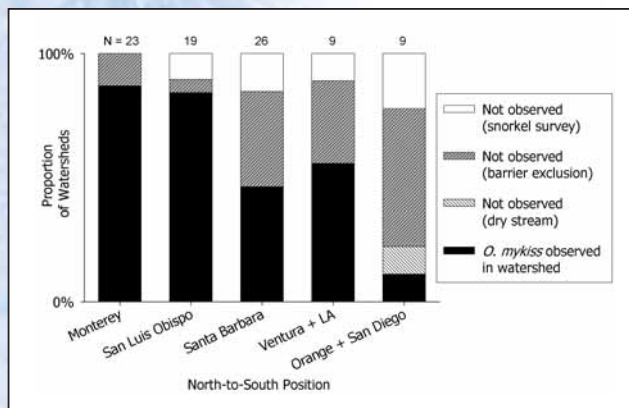


Figure 1. Occurrence (by county) of anadromous *Oncorhynchus mykiss* as of 2002, in coastal basins (sub-basins for the Pajaro and Salinas systems) in which the species had been recorded historically. 'Barrier exclusions' refer to systems in which impassable dams or other human-made barriers block access to spawning or rearing habitat. Many of these basins have extant non-anadromous populations of *O. mykiss* above the barrier.

The alarming thing is the climate. Tree-ring data indicate that the climate has become warmer and wetter since the 19th century, when the Little Ice Age ended. Oxygen isotopes in shells at archaeological sites reveal a corresponding rise in sea-surface temperature, by about 2-3° C since 1700. The future looks to be warmer still, and possibly drier, according to forecasts by Mark Snyder and others at the University of California Santa Cruz (UCSC).

To a first approximation, stream temperature tracks air temperature; and summer base flow is a function of annual precipitation and watershed size. Matthew Goslin of UCSC, Fred Watson of California State University Monterey Bay and I used these relations to prepare maps of potential steelhead habitat, based on the climate of the past 40 years and the geomorphology of coastal stream networks. We used known occurrences of juvenile fish to estimate the species' tolerance limits along each environmental variable (known as a Bioclim or envelope model). The results advance the idea that oversummering habitat is largely confined to four areas: the immediate coast, the Santa Cruz Mountains, the Carmel River and headwater streams of the east side of the Santa Lucia Mountains.

As of 2002, the species was still widespread in coastal creeks from San Francisco to Cambria (and beyond), according to surveys we conducted in that year. (See Figure 1.) In Big Sur we found the species in all the coastal basins in which it had been recorded historically, even the tiniest systems such as Partington and Plaskett Creeks. This fact hints at the idea that small populations, usually

thought to be extinction-prone, may be unusually resilient in Big Sur. Meanwhile, steelhead numbers have rebounded in the Carmel River, believed to be partly a result of changes in water and fisheries management and partly a result of the Pacific Decadal Oscillation, which has apparently improved ocean survival of salmonids throughout the West Coast. Clearly, the species is quite resilient under the right conditions. Nevertheless, nowhere is there evidence for the steelhead numbers of a century ago.

Rainbow trout, which stay in fresh water their entire lives, have steelhead as progeny and vice versa. We suspect that environmental cues may influence which of the two strategies a juvenile fish adopts – a hypothesis currently being tested experimentally by Sue Sogard of the National Oceanic and Atmospheric Administration (NOAA), Rob Titus of California Department of Fish and Game and Marc Mangel of UCSC. The rainbow trout 'option' clearly confers resilience on steelhead populations, allowing, for example, the species to persist above impassable dams such as those on the San Antonio and Nacimiento Rivers near Camp Roberts. Genetic studies we conducted in collaboration with Anthony Clemento and Eric Anderson of NOAA and Derek Girman of Sonoma State University indicate that the fish above these dams are not descendents of hatchery fish but are as closely related to existing steelhead populations as the latter are to each other.

Coastal estuaries also appear to confer resilience. Some years ago, Jerry Smith of San Jose State University showed that over-summering juveniles grew very fast in certain lagoon estuaries. In a recent study of Scott Creek steelhead, Sean Hayes of NOAA confirmed this result and suggested that it confers improved ocean survival. By analyzing scales, Hayes found that 'early fast growers' were disproportionately over-represented in the adult steelhead returning to Scott Creek during his four-year study.

These results suggest that the species has the capacity to respond rapidly and positively to the appropriate recovery actions, such as improvements in lagoon condition and restoration of migration corridors. Still, the climate trends are quite worrisome, because they are so overarching. Further south, geologists Lee Harrison and Ed Keller of the University of California Santa Barbara have begun to find that juvenile steelhead are often limited to stream reaches where geologic faulting forces cool, reliable underground base flows to the surface. These are stream reaches that defy climate, so to speak, and we do not yet know if they are widespread or common.

– DAVID BOUGHTON
NOAA FISHERIES, SOUTHWEST FISHERIES SCIENCE CENTER

MARINE MAMMALS

Dolphins of Monterey Bay

Dolphins, with 33 species worldwide, possess a complex brain, social and communication system and are highly adapted physiologically for life at sea. Dolphin schools are composed of subgroups that include closely related individuals, with the strongest bonds among related females. Although subgroups generally remain intact, the overall school size fluctuates. In contrast to baleen whales, which migrate seasonally to specific feeding and breeding areas, most small cetaceans exhibit more subtle seasonal changes in distribution, abundance and behavior. Factors such as



Northern right whale dolphins

Southwest Fisheries Science Center/NOAA

ECOSYSTEM OBSERVATIONS

for the Monterey Bay National Marine Sanctuary

2005





CREDITS

Editor – **Jenny Carless**

Graphic designer – **Judy Anderson**

Production artist – **Chris Benzel**

Reviewers – **Andrew DeVogelaere, Dawn Hayes, Liz Love, Holly Price**

Photographers – as noted and:

Front and back covers: **Chad King**

Illustrations as noted and:

© Monterey Bay Aquarium

© Illustrations and photos copyright – all rights reserved. Illustrations and photos may not be reprinted or reproduced without written permission.

National Oceanic and Atmospheric Administration

Monterey Bay National Marine Sanctuary

299 Foam Street
Monterey, CA 93940
(831) 647-4201

<http://www.montereybay.noaa.gov>

We welcome comments, which should be sent to Dawn Hayes, education coordinator, at the address above.

Unless specifically stated, the views expressed in this issue do not necessarily reflect the opinions of the Monterey Bay National Marine Sanctuary, the National Marine Sanctuary Program or NOAA.



PRINTED ON RECYCLED PAPER

The sanctuary thanks the following individuals and organizations for contributing their time and effort to this publication – as writers, reviewers and advisors:

Scott Benson, NOAA Fisheries – Southwest Fisheries Science Center

Nancy Black, Monterey Bay Cetacean Project

David Boughton, NOAA Fisheries – Southwest Fisheries Science Center

Nicole Capps, Monterey Bay National Marine Sanctuary

Andrew DeVogelaere, Monterey Bay National Marine Sanctuary

William J. Douros, Monterey Bay National Marine Sanctuary

Peter H. Dutton, NOAA Fisheries – Southwest Fisheries Science Center

William F. Gilly, Hopkins Marine Station, Stanford University

Karen Grimmer, Monterey Bay National Marine Sanctuary

Frances Gulland, The Marine Mammal Center
Jim Harvey, Moss Landing Marine Laboratories

Dawn Hayes, Monterey Bay National Marine Sanctuary

Kimberly Heiman, Hopkins Marine Station, Stanford University

Laird Henkel, Moss Landing Marine Laboratories

Bridget Hoover, Monterey Bay Sanctuary Citizen Watershed Monitoring Network

Carrie Kappel, Hopkins Marine Station, Stanford University

Scott Kathey, Monterey Bay National Marine Sanctuary

Kristen Kusic, Department of Ecology and Evolutionary Biology, University of California Santa Cruz

Haven Livingston, Department of Ecology and Evolutionary Biology, University of California Santa Cruz

Liz Love, Monterey Bay National Marine Sanctuary

Peggy Lynch, Hopkins Marine Station, Stanford University

Jacqueline Martin, Hopkins Marine Station, Stanford University

Rebecca Martone, Hopkins Marine Station, Stanford University

Fiorenza Micheli, Hopkins Marine Station, Stanford University

Sean Morton, Monterey Bay National Marine Sanctuary

Hannah Nevins, Moss Landing Marine Laboratories

Barb Peichel, Elkhorn Slough National Estuarine Research Reserve

Wayne Perryman, NOAA Fisheries – Southwest Fisheries Science Center

Holly Price, Monterey Bay National Marine Sanctuary

Peter Raimondi, Department of Ecology and Evolutionary Biology, University of California Santa Cruz

Robert V. Schwemmer, National Marine Sanctuaries West Coast Regional Maritime Heritage Program

Rebecca Stamski, Monterey Bay National Marine Sanctuary

Richard P. Stumpf, NOAA, National Ocean Service

Chad L. Widmer, Monterey Bay Aquarium